module, 8 different broadcast lenses required in each module on the left half, which are replicated, by rotational symmetry, for the right half. That is, lenses for module **1** are identical to those for module **4**, and those of module **2** are identical to those of module **3**.

[**0507**] The situation is a bit more complicated with nine modules arranged in a 3-by-3 fashion. In this case, by symmetry considerations, there are a total of three different collecting lenses and nine different broadcast lenses. For a 4-by-4 arrangement, there are three different collecting lenses, with the proviso that the placement of these collectors follows a reflection about the several symmetry axes. The number of distinct broadcast lenses jumps to 32 with 54 distinct facets among the total of 8×16×16 or 2048 in all.

[**0508**] If all collectors are to be placed in the same plane, then FIG. **48** implies that two of the collectors in the 1-by-4 case will require either split or compound lenses; while a minimum of 5 in the 3-by-3 example will need to be split or compound. For the 4-by-4, either 8 or 12 of the lenses will be split or compound. Of course, for any magnification other that the one determined by geometry (as given by Equation (7)), all lenses will be either split or compound.

[**0509**] Macro Distortions Reduced by Correcting Collector from Spherical to Aspheric

[**0510**] A distortion of the image or focal plane may still be found in the distribution-collection methods disclosed herein. By adding small aspheric expansion terms to the standard spherical terms in the expression for the surface of the collecting lens, it is possible to reduce the effect of such focal-plane distortions.

[**0511**] Summary of Method & Benefits

[**0512**] The invention includes two inter-related parts: (1) designing a faceted broadcast lens in conjunction with (2) an appropriate collecting lens. This combination solves many of the optical and intensity problems inherent in a broadcast FSOI. Among these problems are focal plane distortion, image-region distortion at individual receivers, inadequate intensity, especially when scaling to larger systems.

[**0513**] The above discussion has presented design methods for realizing the simplest possible optical system involving an array of coplanar broadcast and collecting lenses. In this simplest case, it is feasible to realize the lens array as a molded array of Fresnel lenses in a single sheet of nominal thickness. Both broadcast (facet) lenses and collecting lenses may be plano-convex, resulting in an inexpensive optical system.

[**0514**] A minor complication was required to vary the system magnification from the geometrical magnification. This change required that a second, curved surface be added to the collector by either making the lens thicker or adding a second lens plane containing this second surface as an additional plano-convex lens, which may also be fabricated as a sheet of Fresnel optics.

ADVANTAGES OF THE INVENTION

[**0515**] The invention provides advantages in the context of supercomputing. Communications between processing nodes is one of the central bottle necks found in supercomputers. The methods disclosed herein overcome the latency problems associated with interprocessor communications by interconnecting all nodes in a system with light. The resulting interconnect is smaller and faster than existing cross-bar and fat-tree methods. In addition, the invention allows efficient broadcast models to be directly implemented rather than simulated as is presently done.

[**0516**] The invention provides advantages in the context of switching and routing. Configured as an optical switch, any node in the system can broadcast information to all other nodes. If each information packet has an associated routing header, any one or several receiving nodes that recognize that header can accept the information packet and transmit it out of the optical switch to the appropriate recipient.

[**0517**] The invention provides advantages in the context of associative memory. In simplest terms, memory association is a method of posing a query as to the presence or absence of a certain item. A code for the item in question is broadcast to all portions of the system. These portions are searched in parallel and any positive responses are reported back to the querying node. The effect is that of an associative memory. Such an associative memory can be very large and distributed by making use of hashing tables at each processing node (module), such hashing tables contain references to remote memory stores such as disk drives or internet resources.

[**0518**] The invention provides advantages in the context of sorting and merging. The broadcast capability allows a multiprocessor system to carry out sorting algorithms more efficiently than presently used interconnect methods. A table or list to be sorted is broken into n small pieces and each piece is sent to one of n processing nodes (modules) where it is is finished to coordinate the merging phase. Each processing node (module) then sends its table element-by-element in ordered fashion to the merging node where the results are placed in the final table in sorted order. Comparisons are done in the merging node (module) to achieve the overall order based on range information received from each of the partial-sorting nodes (modules).

[**0519**] The invention provides advantages in the context of communications processing where one light path is used to simply transmit a communication stream while the other n^2-2 paths split up the data stream into multiple processes on independent processors, each of which might search for a different pattern or condition without affecting or interfering with the primary communications path. The invention provides advantages in communications processing where forward error correction can be effectively and efficiently done on the communications stream in place and on-the-fly. The invention provides advantages in communications processing where individual data packets representing voice messages can be decoded into sampled audio, such sampled audio is then subjected to further processing such as speaker or speech recognition even as the uninterrupted path through the system continues to carry the original message.

[**0520**] The invention provides advantages in the context of image processing where each portion of the image is sent to a different processor for a particular type of filtering operation, all such filtering operations taking place in parallel. The final image is then reassembled at a single node in the system.

[**0521**] The invention provides advantages in the context of pattern recognition on signals or images where the